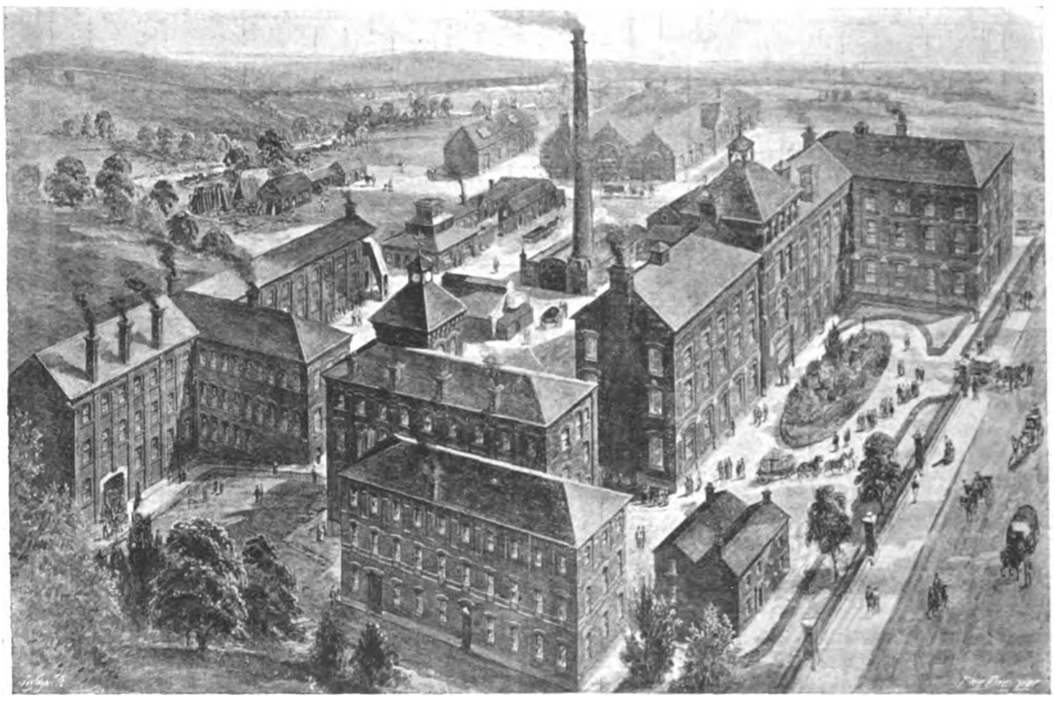
THE MANUFACTURE OF NEEDLES.

In the needle-making trade we have an excellent example of the strict confinement of an industry to a certain district. All the centres of the needle trade in the world could be enumerated on the two hands, and those of any importance on one. In France there are no factories, in Germany and Austria only two or three of any importance, in Russia a works has been started only recently, and in America there is no large factory. In England the industry is centred entirely in Redditch. Here there are fifty firms, varying in size from the smallest to the largest. The most important here and in the world is that of Messrs. H. Milward and Sons, Ltd.



NEW WASHFORD MILLS

Fishing-tackle manufacture is carried on side by side with the construction of needles. Men, boys, women, and girls are employed in the business, the total number of hands engaged at Messrs. Milward's being about 800. The annual output of needles reaches the enormous number of 350 millions, equivalent to well over a million per day when Sundays and holidays are deducted. To every part of the globe inhabited by men and women sufficiently in contact with civilisation needles are sent either direct from Redditch or from the great shipping centres.

At one time the *manufacture* of needles was carried on at Redditch, like the weaving industry in Lancashire and chain making in Cradley Heath, in separate households, the only difference being that, instead of the article being constructed from start to finish in one house, the various operations were performed in different households. This was practically necessitated by the fact that between twenty-five and thirty separate and distinct operations are performed in the manufacture of needles between the cutting of the wire into lengths and the packing of the needles for sale. Another fact which is sufficiently astonishing is that it takes between eight and nine days to make a needle. By far the greatest part of this time is taken up in the polishing or "scouring" process, which alone takes seven days, each operation of that process requiring one day. This we shall describe in detail at its right place, and we will now follow a needle through the factory—from the store, where the cut wire is received and distributed in bundles, to the packing room, where the finished needles are put up in packets and cases and prepared for sale.

Before, however, we commence our description, we wish to correct a false impression concerning the needle trade which has been given by certain statements which have circulated in the Press. These statements were to the effect that English manufacturers were unable to do the work as well as it was done in Germany. We are glad to be able to say that the most conclusive disproof of this assertion is at hand. This disproof, moreover, not only removes the stigma from our English manufacturers, but actually places it on the shoulders of the German maker. The Calyx-eyed needle is well known. The difficulty of its manufacture will, we trust, be appreciated by the readers of this article. It was invented by a German, Herr Kratz. But none of the German firms could or can make it, and it was only after years of careful work and exhaustive inventing that Messrs. Henry Milward and Sons were able to bring the manufacture of it to the perfection it has reached to-day. A better argument for the reinstatement of the honour of our English firms could not be required.

The first operation in the manufacture of needles is the cutting to lengths of the steel wire. This was at one time done by Messrs. Milward at Redditch, but recently they have found it better to have it done at their wire mills in Sheffield, so that now the wires are received at the store in bundles, and assorted in accordance with length and thickness. The wires are of such length that every piece will form two needles. From the store these cut wires are sent to the pointing room—Fig. 7, page 299. Here the two extremities are given the long tapering ends characteristic of needles, the extreme point being sharpened at a later stage, after the needle is hardened. As it would be impossible to give complete drawings of the various machines in the space at our disposal, we shall use hand sketches to make the description of the various processes clearer. These must be regarded merely as diagrams. Fig. 1 is such a sketch of a grinding machine seen in plan, and Fig. 2 of a front elevation of it. A in both cases is the grindstone, revolving in the direction of the arrow at a high speed—between 1500 and 2000 revolutions per minute. B is an india-rubber-covered feed drum, slowly revolving in the direction indicated. It is set obliquely, as shown, but at a far smaller angle. The pieces of wire are placed in a shoot at C and are fed forward by the operator until they come, one by one, into contact with the rubber, which rolls them slowly across the rapidly-rotating grindstone. A moment's reflection will show that the combined effect of the concavity of the grindstone and the inclined position in which the needles cross it must cause the end of the wire which is pressed against the stone to be tapered. The wires lie quite close to each other, practically touching, so that they move from one side of the machine to the other in a steady stream. Behind the drum a sheet of sparks flies out and curves downwards, drawn by the air draught into the cleaning house, where the air, with its cargo of minute atoms of steel, passes through a series of wet filters, by which all the injurious metal and stone particles are removed, and a form of sludge which constitutes a very fair cement produced. Messrs. Milward and Sons have one of the most successful filter houses in the country, and the consequence is that one of the great dangers of the grinding process is entirely removed. Another of the dangers of the trade in the old days was the bursting of grindstones, which was very frequently followed by fatal results. These stones are not large, the maximum diameter being perhaps 2ft.; but the speed of rotation and the consequent centrifugal force are very great. The stones are now very thoroughly tested before use, being caused to revolve at a speed of 1900 revolutions per minute for fully ten minutes. For this purpose they are mounted in a small chamber on a special frame, and are driven at high speed by belt gearing. Over the wheel is placed a heavy steel plate. The gear for throwing the strap on to the fast pulley is worked by a chain, led through the wall of the building. The operator having fixed the stone, retires and closes the room; he then pulls the chain and sets the stone in motion. It is left to itself for twenty minutes, during which time it is getting up to its maximum speed, running at that speed for about ten minutes, and slowing down again after the gear has been "thrown out." About five stones are tested per week. At one time the stones were tested at 3000 revolutions, or double the speed at which they were required to run. The consequence was, that three out of five burst incontinently. At the same place the stones are trimmed up for use; but the true curve has to be maintained by the operator of the machine, who, by watching the ends of the needles and noticing where they get hot, can tell what part of the stone is bearing too hard. The whole time he is at work he watches the stone, and fettles it continually with a tool held in one hand, whilst he attends to the feed of the wires with the other.

OLD WASHFORD MILLS

The wire having been pointed at both ends, a short length in the middle of it is polished bright by an emery-grinder. This operation is called "skimming." It then passes into the stamping room—Fig. 8, page 299. The object of the polishing is to save the stamping dies by removing the hard skin from the wire. The stamping and eyeing are two distinct operations; in the calyx-eyed needle the extra work involves four operations. First, the wire passes between the dies, and the heads are, with their grooves and gutters, shaped out, but no hole is punched through. The heads of a pair of needles in this condition are shown in Fig. 3. The machine stamp has now practically superseded the old foot-stamping press. In the latter a weight attached to a cord passing over a pulley in the ceiling was raised by the pressure of the foot on a stirrup. The needle was placed in position between the two dies and the weight dropped. The dexterity that the operators attained in performing this operation is astonishing, the average number of wires per man per day reaching as much as between 27,000 and 28,000. The machine, which operates in a somewhat similar manner, except that a spring and cam replace the weight and foot, is not much more rapid in its action. In the machine the wires are fed at a regular rate by falling into transverse grooves in the periphery of a wheel, from which they drop into position on the lower die, are stamped, and immediately thrown off by two steel fingers into a tray placed to receive them. In the next operation the eyes are punched out—Fig. 9, p. 299. The old hand method of punching eyes is still used to a small extent. The well-known screw die press is used. The stamped head is fitted by feet into a matrix that exactly fits it, and the double punch comes down and drives through the holes. This operation has to be done twice with the calyx-eyed needles, as there are five holes to every pair of needles, the central hole when the needles are separated forming the notch, and it is found impracticable to punch them all at once. Finally, with these needles the split has to be made just as in a steel pen. At first a good deal of difficulty was experienced in getting the automatic punching machines to work, partly owing to the prejudice of the workpeople and partly to the intricacy of the machine. The needles pass in a regular continuous stream through the machine. They enter sideways, and pass at regular intervals along a slide, being carried forward by dropping into the threads of two screws. As each needle approaches the punching tool it comes against a knife-edge, which, passing between the two heads, lines the two needles up in position longitudinally; further on it comes against a pair of steel stops which bring it into place under the die, which then punches the hole. A pair of trips then lift the needle over the stops. The success of these two operations depends almost entirely upon the stamping and eyeing dies. The fashioning of these dies demands a great amount of skill, the stamping dies calling for the greatest care and nicety in their manufacture, and being more difficult of construction than the punching dies. A glance at a needle, no necessarily of small size, will convince any one that t

Digitized by Google

THE MANUFACTURE OF NEEDLES—MESSRS. H. MILWARD AND SONS' WORKS, WASHFORD MILLS, REDDITCH

(*For description see page* 298)

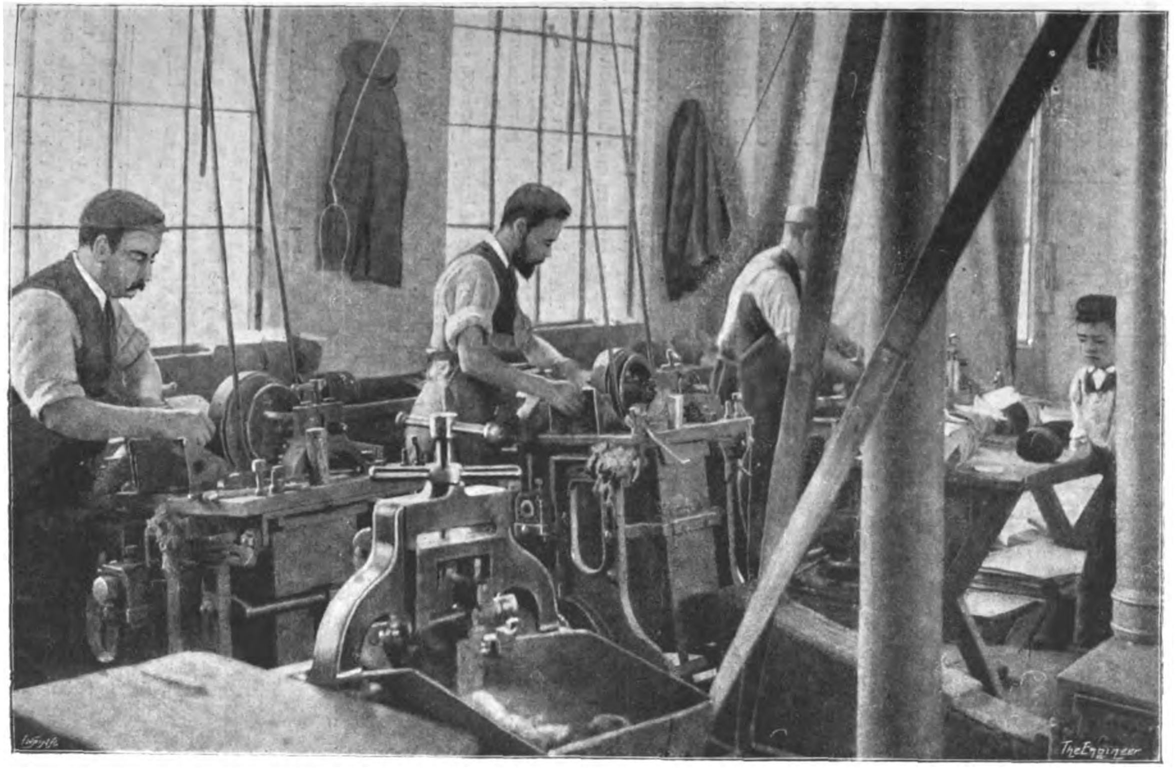


Fig. 7—POINTING ROOM

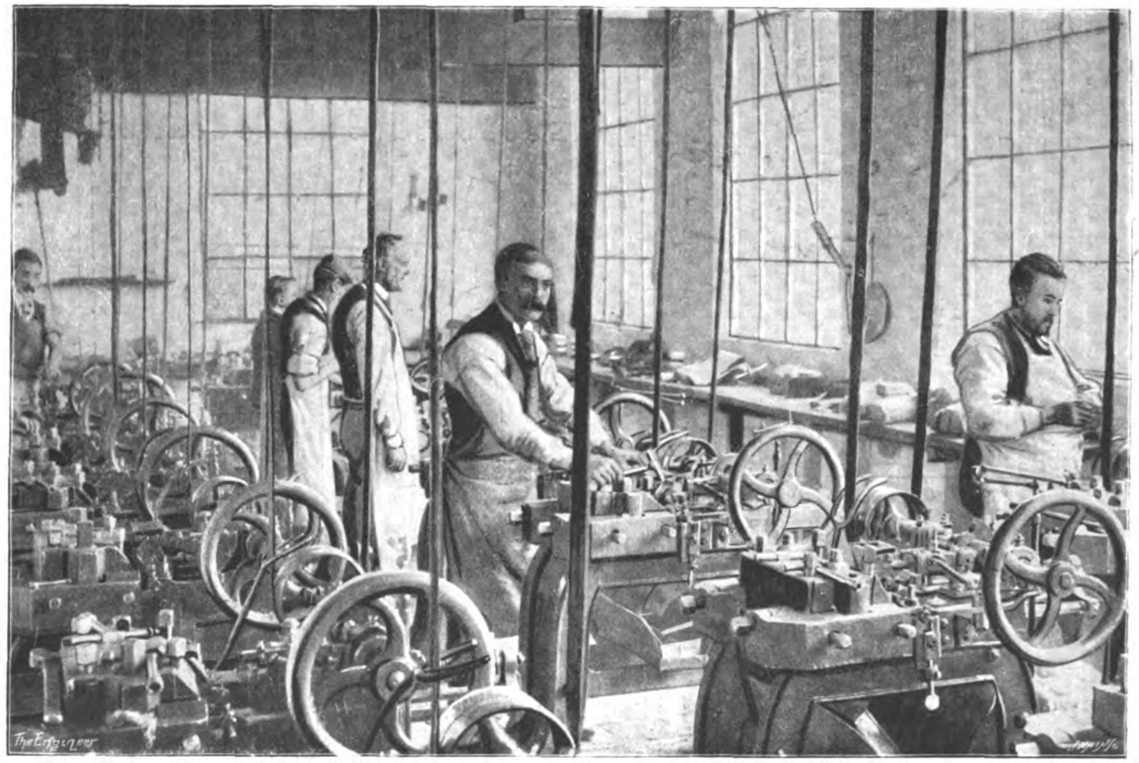


Fig. 8—STAMPING ROOM—MAKING IMPRESSION FOR EYES

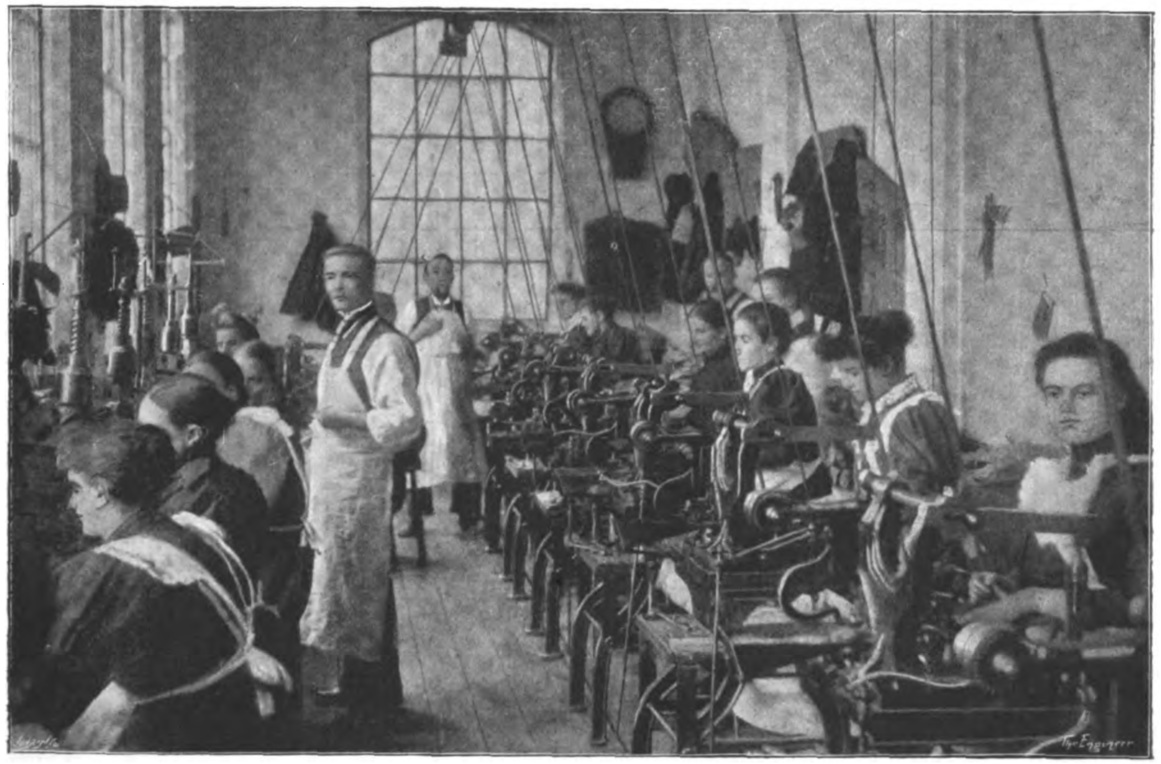


Fig. 9—EYEING ROOM

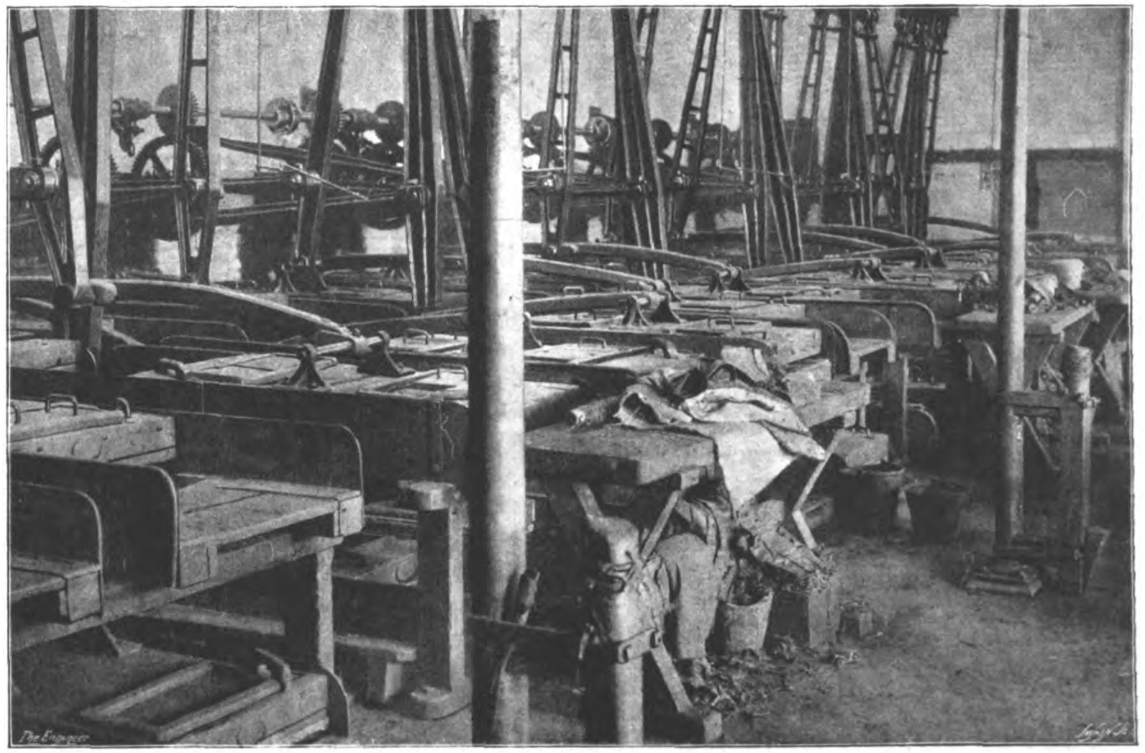


Fig. 10—SCOURING ROOM

cut dies to fashion the shape of the head, to make the "gutter" or channel, &c., and to deeply indent the eye which the punch is subsequently to pierce, would be practically impossible. The only method at once feasible, practical, and economical, is to stamp the dies. For this purpose a male die is first made by taking a suitable piece of soft steel narrowed down almost to a chisel edge, and carefully filing such notches and indentations in it, so that after it is hardened and impressed into another similar piece of steel it shall impart to the latter a female impression of its own form. This, the working die, is then trued up as may be required in certain parts, and when hardened is ready for use. The original male punch is, of course, capable of turning out a large number of female dies, and it has moreover the essential feature that any pair of dies struck by it are identically the same. It is perhaps unnecessary to remark that the punch is double, that is to say, that it forms at once dies which impress the two heads at the same time, as shown in Fig. 3.

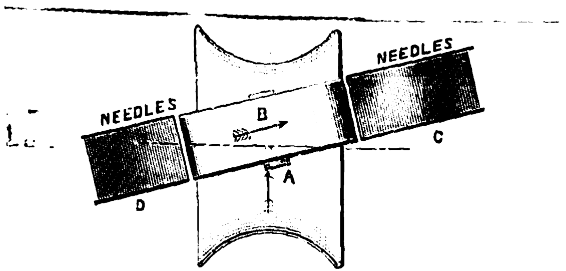


FIG I

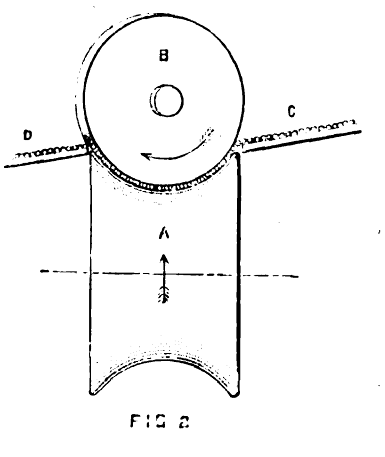


FIG 2

The needles or wires having been eyed, pass into the hands of boys who "spit" them. In one hand a boy holds a number of the needles, keeping them flattened out on his forefinger by his thumb. In the other hand he takes two small steel wires, and works them simultaneously through the eyes of the needles, making up a string of needles some 6in. or 7in. long. The rapidity and apparent ease with which this threading of the needles is done is surprising. The filer then takes a string of these needles, and clamps them in a special vice, as shown by Fig. 4. In this way he files off the burr on either side of the head produced in the stamp—see Fig. 3. Having done both sides thus, he holds one set of needles in one hand, and with the other pulls the second row of needles towards him, in such a manner as to effect a fracture along the thin part between the eyes A B, Fig. 3. He now has two strings of single needles. One of these he clamps in a suitable hand vice, and files away the square corners, and gives the proper roundness to the top of the head.

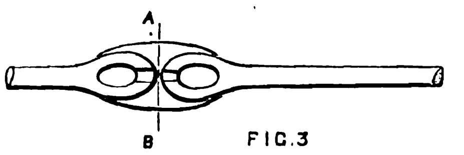


FIG.3

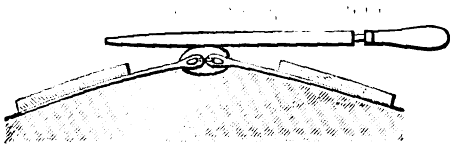


FIG.4

It is now necessary to clean out any burr that may be left inside the eye, and which, if left, would cut the thread. To do this the needles are removed from the wires on which they are threaded, and strung on others which are very slightly roughened. A number of these wires, with their needles hanging from them, are hung horizontally from rods on a table which continually moves backwards and forwards in the line of the wires, so that the needles swing backwards and forwards on them.

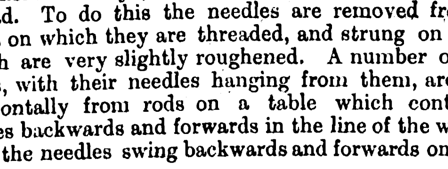


FIG.5

This is allowed to go on for a time, till the eyes are well polished inside. The needles, which have been soft up to this point, have now to be hardened and tempered. This is done by first plunging them, whilst hot, into oil, and so hardening them, and then lowering them again by passing them through a furnace kept at a temperature of about 300 deg. Fah., and employing a very ingenious method peculiar to Washford Mills, of ensuring uniformity in the temper.

All the work done on a single needle so far could be completed in a few hours. But we now come to the operation of scouring, which requires seven days for its proper accomplishment. The needles, mixed with soft soap and fine emery, are made up into long cigar-shaped bundles, covered with stout canvas. About 40,000 needles go into each packet. Two such packets are put upon a table underneath a board or "runner," which reciprocates continually, thus rolling the packet round and round and backwards and forwards, and so causing the needles to rub against each other, and with the help of the emery to clean each other. After twelve hours the packet is opened, and the needles very thoroughly washed. They are again made up, and go through the same operation again; this is repeated several times. The finally cleaning is given by using putty powder—stannic oxide—in place of emery. At Washford Mills there are 128 packets under treatment at a time, or about 5,000,000 needles. There are thirty-two double runners, each runner carrying four bundles—see Fig. 10, p. 299. The runners are supported on long rods from the ceiling, and are rocked backwards and forwards by cranks. It is an interesting fact that a very considerable saving of steam has been effected by setting every one of these cranks at a different angle, so that the turning moment on the driving shaft is constant at all parts of its revolution. The scouring process gives to the needles a high "glaze" or "colour," almost indistinguishable to the inexperienced eye from the polish which is ultimately given to them.

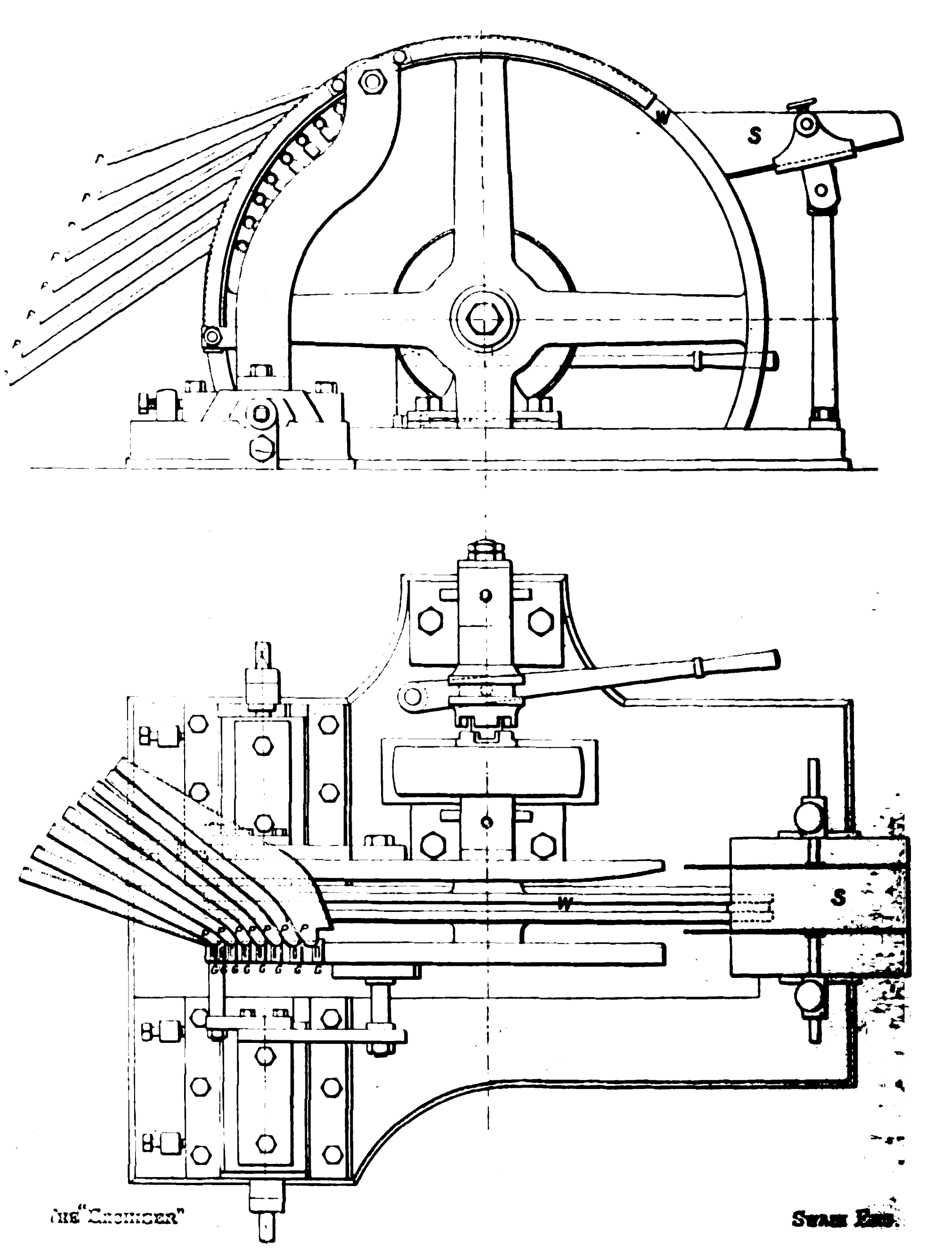


Fig. 6—HANDING MACHINE.

Naturally the rough treatment which the needles have received in the various operations through which they have so far gone, and particularly the last, has damaged a proportion of them in various ways. To pick out these defective needles is the work of women, and, with the exception of a few cases, is entirely dependent upon skill and dexterity. The needles are sent in packets into the handing room; each woman receives a packet. With one hand she spreads out a number of these needles on a planished stone, and running the needles under the fingers of one hand, she rapidly picks out all those that are bent or defective. It is practically impossible to describe the process, which is only acquired by prolonged practice. The crooked needles, having by this means been separated from those which are straight, they pass to another operator, who, on a similar stone, runs them one by one under the middle finger of her right hand, and with gentle taps from a light hammer held in the other hand straightens them. The needles now, though not in any tangle or confusion, do not all lie with the points in the same direction. It is necessary that they should do so before proceeding. Two methods of "heading," as it is called, are followed. In the original method a woman or girl spreads a number of needles in a row on the table, at which she sits with her left hand, and brings the first finger of the right hand, round which is wrapped a piece of linen rag, against the end of the row; all the needles whose points touch the rag adhere to it and are pulled away. Twenty or thirty needles are attacked at a time. The newer operation is more rapid, more mechanical, and more ingenious. In front of the operator is a board with a steel edge raised about half an inch above the edge of the table. The needles are spread rapidly out along the board, with their extremities towards the steel edge. Then a long square ruler is placed against the other ends and moved gently forwards. At a certain instant all the needles whose heads are projecting beyond the steel edge overbalance and stand up on end, whilst those whose heads are on the board remain horizontal. The sudden upending of all the points has a magical appearance. The operator then carries the ruler forward against the upstanding ends, and pushes all those needles over, so that they lie in the same direction as the others, which are then pushed forward to join them, the whole lot now pointing in the same direction. Fig. 5, in which the movements are numbered 1, 2, 3, will perhaps make this little operation clearer.

Although all the needles in each packet are of the same size and number, there are unavoidable slight differences in the lengths. The machine, made by Messrs. Manlove, Alliott, and Co.—illustrated by Fig. 6—sorts all the needles according to length. Its operation will be readily understood. A drum W is caused to revolve at a slow regular rate. Across its face are cut at short intervals grooves, into which the needles sliding down the shoot S fall, each groove taking one needle. On the opposite side of the machine, facing the feeder, are placed a number of steel gauges S, each one placed a very small fraction of an inch in front of the other. Eight gauges are commonly used. The needles are "dressed" by the heads. The point of the longest needle is caught by the first gauge, up which it slides till it comes against a pin, which turns it sideways and allows it to pass down the first delivery shoot into a receptacle placed for it. Only the shortest needle gets through to the end, some one or other of the gauges picking out the intermediate sizes. Of course all the needles so assorted are kept carefully together, and go into the same packets. The greatest difference in length between any two needles is about $\frac{1}{100}$in. In the same room where these machines work there are others for counting needles and for selecting a given number of needles from a number of sizes. In the former the needles are received in a similar drum to that just described, and each needle as it passes a certain point in its course gives a partial rotation to a wheel actuating a differential counter. The needles are afterwards weighed as a check.

The needles have now to be ground. This includes giving the fine point, or "set," which is done by a machine which passes them rapidly across a small emery stone. The heads and the countersink of the eye have also to be polished. These operations are done by hand, or by simple machines. In either case, for the heads leather wheels dressed with fine emery are used for the first; and wheels, in which a number of round-headed steel pins project from the periphery, for the second. The eyes of the needles are held against these pins, which enter the grooves or gutters and burnish them.

The final operation in the manufacture of the needle is the polishing. This is done by an exceedingly ingenious machine invented and patented by Mr. Milward, and made by Messrs. Manlove and Alliott. It performs its work three or four times as fast as the hand polishers. The needles are first placed in a species of hopper or box, from which they are doled out a row at a time into the machine; they go in extremity first. Rollers underneath do the polishing and a rotary motion is imparted to them to ensure their being polished on all sides. Having received the final polish the needles pass into the packing room, where they are put up into the packets and cases with which we are all so familiar, and from there they pass through the store on their road to the world. On page 298 two pictures of the Old and New Washford Mills, the works of Messrs. H. Milward and Sons, are given. However much the former may be preferred from an æsthetic point of view, in every other sense the new mills are far superior and on page 299 views of the principal departments in the new mills are given.

Mason University College Engineering Society.—At meeting of the above Society, on March 24th, the President in the chair, a paper was read by Mr. F. H. Hummell on "Motor Cars." The author determined the magnitude of the various resistances which a motor car has to overcome, and from these the necessary power of the motor. He then discussed the advantages and disadvantages of various types of motor, showing that a motor must be selected according to the particular work has to do; and in conclusion, showed the respective merits of motor on a carriage body and a motor on a sub-frame the paper being illustrated with diagrams.

Digitized by Google